

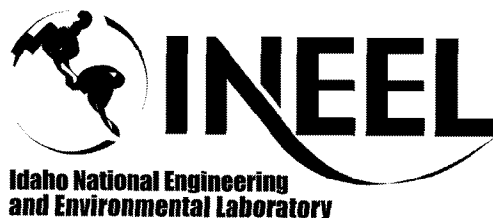
Appendix E

Air Emissions Modeling

Engineering Design File

Dose Calculations for the Projected Emissions from the CFA-08 Cap Installation

Prepared for:
U.S. Department of Energy
Idaho Operations Office
Idaho Falls, Idaho



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ENGINEERING DESIGN FILE

1. Title: Dose calculations for the projected emissions from the CFA-08 cap installation.				
2. Project File No.:				
3. Site Area and Building No.: INTEC-708-001		4. SSC Identification/Equipment Tag No.:		
5. Summary: This Engineering Design File (EDF) presents results of calculations performed with CAP88-PC to estimate the doses caused by emissions of radionuclides projected for the CFA-08 cap installation. The CAP-88 code is required for estimating doses that are used to demonstrate compliance with 40 Code of Federal Regulations (CFR) 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy (DOE) Facilities" (the National Emissions Standards for Hazardous Air Pollutants [NESHAP]). The CAP88-PC software has been approved for demonstrating compliance with the requirements of 40 CFR 61, Subpart H. An effective dose equivalent (EDE) of 2.6E-06 mrem was calculated for the Idaho National Engineering and Environmental Laboratory (INEEL) boundary location 9,600 m SSW of Central Facilities Area (CFA), which is the location of the INEEL maximally exposed individual (MEI) for CFA. The EDE is three orders of magnitude below that reported in the 1999 INEEL NESHAP Annual Report.				
6. Review (R) and Approval (A) and Acceptance (Ac) Signatures: (See instructions for definitions of terms and significance of signatures.)				
	R/A	Typed Name/Organization	Signature	Date
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Checker	R	P. D. Ritter Applied Geosciences	<i>Paul Ritter</i>	3/4/02
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8. Records Management Uniform File Code (UFC):				
Disposition Authority:			Retention Period:	
EDF pertains to NRC licensed facility or INEEL SNF program?: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No				
9.				

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ACRONYMS

CFA	Central Facilities Area
CFR	Code of Federal Regulations
COPC	contaminant of potential concern
DOE-ID	Department of Energy Idaho Operations Office
EDE	effective dose equivalent
EPA	Environmental Protection Agency
INEEL	Idaho National Engineering and Environmental Laboratory
MEI	maximally exposed individual
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NOAA	National Oceanic Atmospheric Administration
STAR	Stability Array
UCL	upper confidence level

Dose Calculations for the Projected Emissions from the CFA-08 Cap Installation

1. SUMMARY

The CAP-88PC code was used to estimate the doses for the maximally exposed individual (MEI) caused by radionuclide emissions from the projected emissions for the installation of a cap over the Central Facilities Area (CFA)-08 drainfield. These calculations were performed using the CAP88-PC, Version 2.0 (Parks 1997). The CAP-88 code (Environmental Protection Agency [EPA] 1990) is required for estimating doses that are used to demonstrate compliance with 40 Code of Federal Regulations (CFR) 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities" (National Emissions Standards for Hazardous Air Pollutants [NESHAP]). The CAP88-PC software has been approved for demonstrating compliance with the requirements of 40 CFR 61, Subpart H (see <http://www.er.doe.gov/production/cr-80/cap88/>).

2. METHODS/ASSUMPTIONS

2.1 Source Term

The remedial action being addressed in this analysis is the capping of the CFA-08 drainfield, located northeast of CFA-1605. Remediation activities will include mulching contaminated vegetation with a mower, which will be left in place. Potential sources of airborne radionuclides during mulching include the release of contaminated particles adhering to plant surfaces and the resuspension of contaminated surface soil particles.

To develop the source term, two major conservative assumptions were made:

1. All of the radiation measured in vegetation is associated with resuspendable particles adhering to plant surfaces. All of these particles will be mechanically dislodged and become airborne during mulching.
2. Radionuclides measured in contaminated surface soil are associated with resuspendable surface particles that can be dislodged during mulching and become airborne at conservatively high rates equivalent to those measured for agricultural operations. The top 1 cm of soil is considered to be the active soil layer (i.e., the layer subject to resuspension).

The vegetation growing on the drainfield contains about $6.7\text{E-}09$ Ci of Cs-137 (Hamilton, Yancey, and Hess 2000). The entire inventory in vegetation was assumed to be released during mulching. For CAP88-PC calculations, the release was annualized (i.e., $6.7\text{E-}09$ Ci/yr).

Table 1 presents concentrations of radionuclides measured in the top 6 in. (0.1524 m) of soil collected from the CFA-08 drainfield (Burgess et al. 2000). For this analysis, it was assumed that each radionuclide is homogeneously distributed throughout the soil volume. The mean concentrations are thus used to calculate the inventories available for resuspension (Table 2). The total radionuclide releases shown in Table 2 were annualized (i.e., Ci/yr) for input into CAP88-PC.

Table 1. Summary statistics for CFA-08 drainfield surface soil (0–6 in.). Data from Burgess et al. (2000).

COPC	Number of Samples	Number of Detects	Concentration					Normal 95% UCL ^b	Lognormal 95% UCL ^b
			Minimum	Maximum	Mean ^a	Std. Dev.			
Cs-137	30	29	0.094	169	2.48E+01	4.52E+01	2.88E+01	1.87E+02	
Pu-239/240	8	3	0.11	2.9	4.27E-01	1.01E+00	1.10E+00	8.14E+01	
U-235	30	1	0.221	0.221	2.45E-02	6.03E-02	4.33E-02	9.97E+00	

a. Arithmetic mean.

b. UCL – Upper confidence limit. A minimum of three samples, with positive detection for at least one of the samples, is required to calculate the UCL.

COPC = Contaminant of potential concern.

Table 2. Estimated releases of radionuclides from mechanical disturbance of surface soil during mulching.

COPC	Inventory (Ci)		Soil Resuspension Rate (sec ⁻¹) ^c	Radionuclide Release Rate from Surface Soil		Release during Mulching (Ci)		
	Vegetation ^a	Soil ^b		Ci/s	Ci/da ^d	Vegetation	Soil ^e	TOTAL
CS-137	6.70E-09	6.92E-03	4.00E-08	2.77E-10	7.97E-06	6.70E-09	1.59E-05	1.60E-05
Pu-239/240	—	1.19E-04	4.00E-08	4.77E-12	1.37E-07	—	2.75E-07	2.75E-07
U-235	—	6.84E-06	4.00E-08	2.73E-13	7.88E-09	—	1.58E-08	1.58E-08

a. Value from e-mail sent by Deborah Wagoner to Marilyn Case on 8/17/01.
b. Arithmetic mean concentration (pCi/g) in top 6 inches of soil multiplied by soil density (1.5 g/cc), area of drainfield (18,605 m²), and active soil depth (1 cm).
c. Resuspension rate for disking from J. W. Healy (1980).
d. Assumes that mulching will be conducted for 8 hours per day.
e. Assumes that mulching will be conducted for 2 days.

2.2 Computer Code and Data

The CAP88-PC computer code (Parks 1997) was used for this analysis. The output from CAP88-PC for individual dose calculations is the effective dose equivalent (EDE), which includes the 50-year committed effective dose equivalent from internal exposure through the ingestion and inhalation pathways and the external EDE from ground deposition and air immersion. The dose conversion factors are from the RADRISK dosimetric database.

The National Oceanic and Atmospheric Administration (NOAA) has collected meteorological data at the 15-m level from the CFA meteorological tower. Data for ten years (1987–1996) was provided electronically by NOAA in Stability Array (STAR) format (Staley and Abbot 1998). The CFA, 15-m STAR file was used directly as input to the CAP88PC code (Ritter 1997).

The source was modeled as an area (18,605 m²) ground-level release with no plume rise. The total releases shown in Table 2 were input as annual releases. Doses were calculated for the Idaho National Engineering and Environmental Laboratory (INEEL) boundary MEI, located 9,600 m SSW of CFA (Staley and Abbott 1998).

The remaining parameter values used for the CAP88-PC code are as follows:

1. The fraction of vegetables produced at home, within the local assessment area and outside assessment areas, was entered as 0.7, 0, and 0.3 (Staley and Abbott 1998).
2. The fraction of meat produced at home, within the local assessment area and outside assessment areas, was entered as 0.442, 0, and 0.558 (Staley and Abbott 1998).
3. The fraction of milk produced at home, within the local assessment area and outside assessment areas, was entered as 0.399, 0, and 0.601 (Staley and Abbott 1998).
4. Default values were used for beef cattle and milk cow density, and the land fraction cultivated for vegetable crops.
5. Annual mean meteorological data from Clawson, Start, and Ricks (1989) were used. This includes an annual precipitation rate of 22.12 cm/yr and an annual ambient temperature of 5.56°C.
6. The height of the tropospheric mixing layer (lid) was assumed to be 800 m (Staley and Abbott 1998).

The CAP88-PC input file is provided as Attachment 1.

2.3 Results

An EDE of 2.5E-06 mrem was calculated for the location of the INEEL boundary MEI, 9,600 m SSW of CFA. This value is three orders of magnitude below the EDE of 7.92E-03 mrem estimated at the MEI for all INEEL emissions for 1999 (Department of Energy Idaho Operations Office [DOE-ID] 2000) and well within the dose limit of 10 mrem for the INEEL. The MEI receptor location used for DOE-ID 2000 is 14359 SW of CFA at Frenchman's Cabin. The INEEL boundary location used in this Engineering Design File analysis thus results in a more conservative calculation than that reported in the annual NESHAP report (DOE-ID 2000).

Copies of the CAP88-PC output files for the dose calculations are provided in Attachment 2.

3. REFERENCES

- 40 CFR 61, Subpart H, July 2000, "National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities," *Code of Federal Regulations*, Office of the Federal Register.
- Burgess, J., S. Flynn, P. Jessmore, J. Keck, S. McCormick, M. Rohe, I. Stephan, R. VanHorn, S. Fu (Mac Tec), and L. Trozollo (Mac Tec), 2000, *Comprehensive Remedial Investigation/Feasibility Study for the Central Facilities Area Operable Unit 4-13 at the Idaho National Engineering and Environmental Laboratory*, Department of Energy Idaho Operations Office, DOE/ID-10680, Rev. 1, July 2000.
- Clawson, K. L., G. E. Start, and N. R. Ricks, 1989, *Climatology of the Idaho National Engineering Laboratory*, Department of Energy Idaho Operations Office, DOE/ID-12118, Revision 0, December 1989.

- DOE-ID, 2000, *1999 INEEL National Emissions Standards for Hazardous Air Pollutants—Radionuclides (Annual Report)*, Department of Energy Idaho Operations Office, DOE/ID-10342, June 2000.
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- EPA, 1989, *Procedures Approved for Demonstrating Compliance with 40 CFR Part 61, Subpart I*, EPA 520/1-89-001, U.S. Environmental Protection Agency.
- EPA, 1990, *The Clean Air Act Assessment Package—1988 (CAP-88), A Dose and Risk Assessment Methodology for Radionuclide Emissions to Air, Volumes 1-3*, prepared by D. A. Beres, SC&A, Inc., for the U.S. Environmental Protection Agency.
- Hamilton, M. A., N. A. Yancey, and J. R. Hess, 2000, *Uptake of Cesium by Native Vegetation on INEEL Soils at the CFA-08 Sewage Treatment Plant Drainfield*, Idaho National Engineering and Environmental Laboratory, October 2000.
- Healy, J. W., 1980, “Review of Resuspension Models,” IN W.C. Hanson, editor, *Transuranic Elements in the Environment*, DOE/TIC-22800, U.S. Department of Energy.
- Parks, B., 1997, *CAP88-PC Version 2.0 User's Guide*, U.S. Department of Energy, June 1997.
- Ritter, P. D., 1997, *Meteorological Data File Processing for GENII and CAP-88—Use of STAR Formatted Data*, Engineering Design File NES-97-004.1.
- Staley, C.S. and M. L. Abbott, 1998, *INEEL Air Modeling Protocol*, Idaho National Engineering and Environmental Laboratory, INEEL/INT-98-00236, July 1998.
- Wagoner, D. J. email to M. J. Case, dated August 18, 2001, subject: “Re: Cost Estimate for CFA-08 NESHAPs Analysis.”

Attachment 1
CAP88-PC Input File

A1-1

A1-2

Attachment 1

CAP88-PC Input File

Sep 12, 2001 12:07 pm Sep 12, 2001 12:07 pm
 CFA08Cap CFAMulch.
 C:\CAP88PC2\WINDFILES\CFA10Y.WND

CFA-08

```

ID
2001
Resuspension of radionuclides in soil and
vegetation during mulching prior to capping.
0 1 0 0 0 1
9600 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
0 0 0 0
800 278.72 22.12
1
0. 18605. 0. 0.
0. 0. 0. 0. 0. 0.
3 0 1
CS-137 D 1.0 9.500e-01 9.500e-01 5.480e-05 1
1.6E-05 0.E+00 0.E+00 0.E+00 0.E+00 0.E+00
2.212e-06 .0018 0.000e+00
1396 1054 1 1 9
PU-239 Y 1.0 1.000e-04 1.000e-03 5.480e-05 0
2.75E-07 0.E+00 0.E+00 0.E+00 0.E+00 0.E+00
2.212e-06 .0018 0.000e+00
3743 2773 2 1 9
U-235 Y 1.0 2.000e-03 2.000e-01 5.480e-05 0
1.58E-08 0.E+00 0.E+00 0.E+00 0.E+00 0.E+00
2.212e-06 .0018 0.000e+00
5607 4366 3 1 9
0.7 0.0 0.3 Entered
0.399 0.0 0.601
0.442 0.0 0.558
T T
7.190e-02 8.560e-03 7.150e-02
CS-137 19 137
00 00 00 00 00 00
0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00
PU-239 53 236
00 00 00 00 00 00
0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00
U-235 72 313
00 00 00 00 00 00
0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00

```

A1-4

Attachment 2
CAP88-PC Synopsis and Summary Reports

A2-1

A2-2

Attachment 2

CAP88-PC Synopsis and Summary Reports

Synopsis Report

C A P 8 8 - P C

Version 2.00

Clean Air Act Assessment Package - 1988

S Y N O P S I S R E P O R T

Non-Radon Individual Assessment

Sep 12, 2001 12:07 pm

Facility: CFA-08
Address:
City:
State: ID Zip:

Source Category:
Source Type: Area
Emission Year: 2001

Comments: Resuspension of radionuclides in soil and
vegetation during mulching prior to capping.

Effective Dose Equivalent
(mrem/year)

2.76E-06

At This Location: 9600 Meters East Northeast

Dataset Name: CFA08Cap
Dataset Date: Sep 12, 2001 12:07 pm
Wind File: C:\CAP88PC2\WNDFILES\CFA10Y.WND

A2-3

MAXIMALLY EXPOSED INDIVIDUAL

Location Of The Individual: 9600 Meters East Northeast
 Lifetime Fatal Cancer Risk: 2.79E-11

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Dose Equivalent (mrem/y)	
GONADS	6.37E-07	
BREAST	3.71E-07	
R MAR	2.40E-06	
LUNGS	8.45E-06	
THYROID	3.91E-07	
ENDOST	2.60E-05	
RMNDR	1.50E-06	
	EFPEC	2.76E-06

RADIONUCLIDE EMISSIONS DURING THE YEAR 2001

Source				
#1 TOTAL				
Nuclide	Class	Size	Ci/y	Ci/y
<hr/>				
CS-137	D	1.00	1.6E-05	1.6E-05
PU-239	Y	1.00	2.7E-07	2.7E-07
U-235	Y	1.00	1.6E-08	1.6E-08

SITE INFORMATION

Temperature: 6 degrees C
 Precipitation: 22 cm/y
 Mixing Height: 800 m

SOURCE INFORMATION

Source Number: 1

Source Height (m): 0.
Area (sq m): 18605.

Plume Rise
Buoyant (cal/s): 0.
(Heat Release Rate)

AGRICULTURAL DATA

	Vegetable	Milk	Meat
Fraction Home Produced:	0.700	0.399	0.442
Fraction From Assessment Area:	0.000	0.000	0.000
Fraction Imported:	0.300	0.601	0.558

Food Arrays were not generated for this run.
Default Values used.

DISTANCES (M) USED FOR MAXIMUM INDIVIDUAL ASSESSMENT

9600

Summary Report

CAP88-PC

Version 2.00

Clean Air Act Assessment Package - 1988

DOSE AND RISK EQUIVALENT SUMMARIES

Non-Radon Individual Assessment
Sep 12, 2001 12:07 pm

Facility: CFA-08
Address:
City:
State: ID Zip:

Source Category:
Source Type: Area
Emission Year: 2001

Comments: Resuspension of radionuclides in soil and
vegetation during mulching prior to capping.

Dataset Name: CFA08Cap
Dataset Date: Sep 12, 2001 12:07 pm
Wind File: C:\CAP88PC2\WNDFILES\CFA10Y.WND

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Selected Individual (mrem/y)
GONADS	6.37E-07
BREAST	3.71E-07
R MAR	2.40E-06
LUNGS	8.45E-06
THYROID	3.91E-07
ENDOST	2.60E-05
RMNDR	1.50E-06
EFFEC	2.76E-06

PATHWAY EFFECTIVE DOSE EQUIVALENT SUMMARY

Pathway	Selected Individual (mrem/y)	
INGESTION	4.82E-07	
INHALATION	2.28E-06	
AIR IMMERSION	3.52E-14	
GROUND SURFACE	1.13E-09	
INTERNAL	2.76E-06	
EXTERNAL	1.13E-09	
TOTAL		2.76E-06

NUCLIDE EFFECTIVE DOSE EQUIVALENT SUMMARY

Nuclide	Selected Individual (mrem/y)
CS-137	3.24E-07
PU-239	2.39E-06
U-235	4.92E-08
TOTAL	2.76E-06

CANCER RISK SUMMARY

Cancer	Selected Individual Total Lifetime Fatal Cancer Risk
LEUKEMIA	2.66E-12
BONE	1.11E-12
THYROID	1.66E-13
BREAST	1.34E-12
LUNG	1.46E-11
STOMACH	8.31E-13
BOWEL	3.45E-13
LIVER	4.72E-12
PANCREAS	7.74E-13
URINARY	4.59E-13
OTHER	9.47E-13
TOTAL	2.79E-11

PATHWAY RISK SUMMARY

Pathway	Selected Individual Total Lifetime Fatal Cancer Risk
INGESTION	8.97E-12
INHALATION	1.89E-11
AIR IMMERSION	8.20E-19
GROUND SURFACE	2.64E-14
INTERNAL	2.79E-11
EXTERNAL	2.64E-14
TOTAL	2.79E-11

NUCLIDE RISK SUMMARY

Nuclide	Selected Individual Total Lifetime Fatal Cancer Risk	
CS-137	8.48E-12	
PU-239	1.88E-11	
U-235	6.49E-13	
TOTAL		2.79E-11

INDIVIDUAL EFFECTIVE DOSE EQUIVALENT RATE (mrem/y)
(All Radionuclides and Pathways)

Distance (m)	
<hr/>	
Direction 9600	
<hr/>	
N	1.1E-06
NNW	8.4E-07
NW	5.4E-07
WNW	5.2E-07
W	6.2E-07
WSW	1.0E-06
SW	2.2E-06
SSW	2.5E-06
S	1.8E-06
SSE	1.6E-06
SE	1.6E-06
ESE	1.7E-06
E	2.0E-06
ENE	2.8E-06
NE	2.2E-06
NNE	1.5E-06

INDIVIDUAL LIFETIME RISK (deaths)
(All Radionuclides and Pathways)

Distance (m)	
<hr/>	
Direction	9600
<hr/>	
N	1.1E-11
NNW	8.6E-12
NW	5.5E-12
WNW	5.3E-12
W	6.3E-12
WSW	1.0E-11
SW	2.2E-11
SSW	2.6E-11
S	1.8E-11
SSE	1.6E-11
SE	1.6E-11
ESE	1.7E-11
E	2.0E-11
ENE	2.8E-11
NE	2.3E-11
NNE	1.5E-11
